RUSSIAN THISTLE POPULATION DYNAMICS AT A FORMER COAL MINE IN NORTHERN NEW MEXICO

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Objectives:

Conduct literature review, evaluate treatment methods, and examine vegetative cover data to determine most effective Russian thistle (*Salsola tragus*) management strategy.

Russian Thistle (*Salsola tragus*)

- Synonyms: *S. iberica*, *S. kali*.
- Annual, up to 3-4’ tall, reproduces by seed
- Short leaves, stiff spine w/red or purple stripes, flowers w/pair of spiny bracts
- Seeds spread as plant dislocates from ground and scattered by wind as “tumbleweeds”
- Seed viability is rapidly lost in soil. Over 90% of the seed germinates or decays in the soil during the first year.

Source: *Weeds of the West*

Russian Thistle Distribution

- Introduced to South Dakota in the 1870s via flaxseed from Russia (Crompton and Bassett 1985)
- Widely distributed in North America except in Southeastern U.S. (41 million ha, Young 1991)
- State noxious weed lists for 46 states

Source: www.eFloras.org

Russian Thistle – Early Considerations

W.S. Long (1941): Valuable forage for wildlife, more protein/carbohydrates than clover, as much mineral salts as alfalfa

Source: Jean Pawek

Life Cycle

Step 1: Seedling establishment

Seed germination requires loose soil.
A deep taproot allows this species to access deeper soil moisture, even as a seedling.

Seed Dispersal

Step 2: Plant Matures

Early leaves are linear and fleshy. Mature leaves are short and spiny, allowing for greater conservation of moisture.

Seed Dispersal

Step 3: Dislocation

- 66,000 seeds/plant (Stallings 1995),
- Up to 250k seeds/plant
- Wind driven, up to 4069 m in 6 weeks (2.5 mi) (Stallings 2012)
- Seed loss is 26% for stationary plants and 66% for tumbling plants (Stallings 2012)

Russian Thistle Control

1. Herbicide and/or mechanical treatments (mowing, tillage, grazing, etc.)
2. “No action”
3. Integrated Weed Management/Reseeding Techniques

Herbicide (case studies):

- Adequate control obtained via broadcast of non-selective herbicides following harvest, using “weed-sensing” sprayer (Stallings et al. 1995)
- Light-activated, sensor-controlled (LASC) sprayer preferred over broadcaster sprayer (42% reduced cost), paraquat preferred over 2,4-D (90% vs. 75% control) (Young et al. 2008)
- Treatments that were superior to a bromacil standard (2 lb/acre) were: bromoxynil at 0.5 and 1 lb/acre, dicamba at 1 lb/acre, and 2,4-D amine at 3 lb/acre (Quimby et al. 1978)
- High undesirable germination with combination of tebuthiuron/ mechanical treatments + drought conditions (Morton 1991)

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Mechanical /Fertilizer (case studies):

- Weed density highest with no-till, use alternative crop rotations (Anderson et al. 1988)
- Nitrogen fertilizer increases crop competitiveness in SW-WW-SUN with no-till, subsequently reducing weed density (Anderson et al. 1988)
- Russian thistle not influenced by nitrogen fertilizer application (Blackshaw & Brandt 2008)
- Exotics and natives did not differ in their response to nitrogen availability, poorest response was an exotic (Lowe et al. 2002)

Russian Thistle vs. Plant Succession

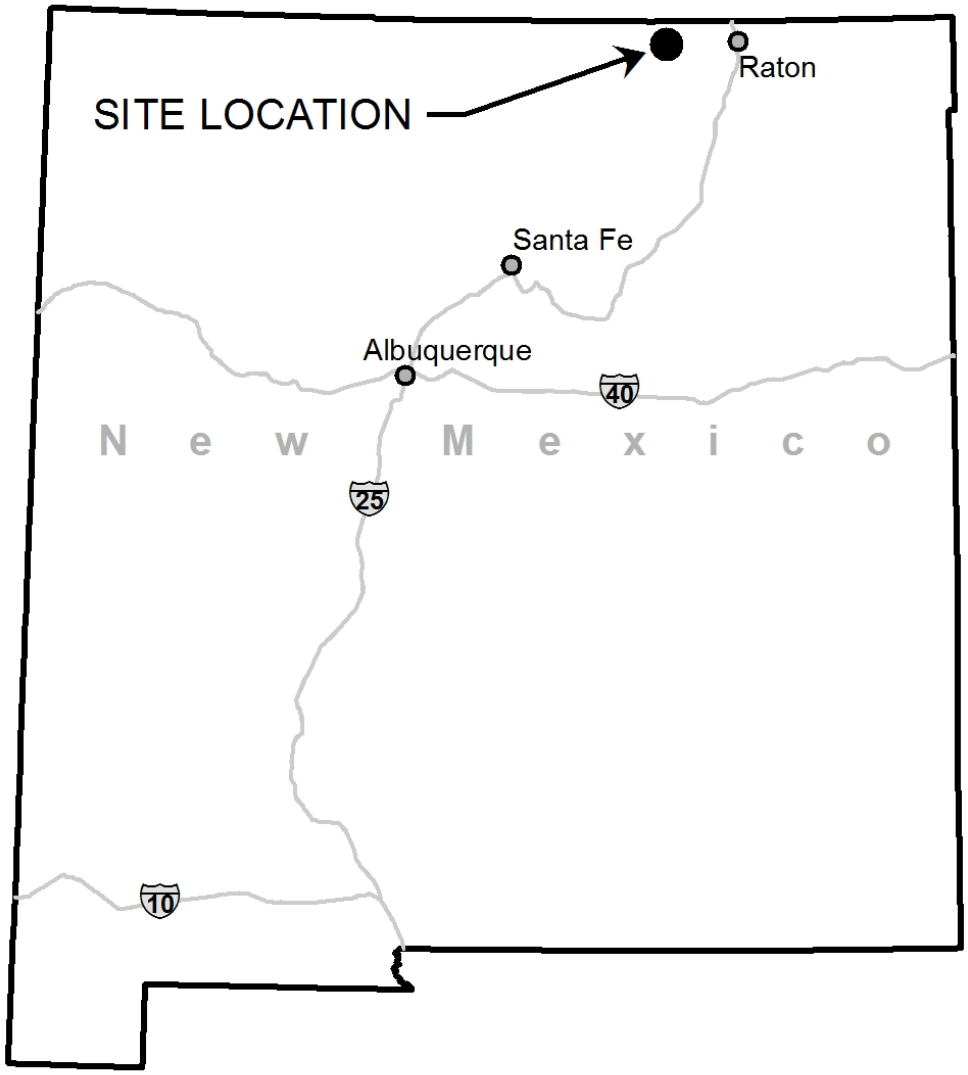
Paschke et al. (2012): Plant community succession driven by initial colonizers following disturbance, initial colonizers strongly influence long-term plant community

- Seeding with early/mid-seral plants had higher number of exotics than planting with late-seral, perennial plants

- Mining bond release standards focus on maximum plant cover with desirables in years 1-4 following reclamation

Question: How can revegetation techniques (i.e. late-seral seed mix) be used to control Russian thistle (or other exotics) in light of rigid bond release standards?

Study Area


SITE LOCATION
Raton
Santa Fe
Albuquerque
40
N e w M e x i c o
25
10

Study Area

- Surface and Underground mining
- Reclamation occurs in 1-90 acre polygons (average size is 15 acres)
- Herbaceous plant community primarily characterized by warm season grasses and cool season forbs
- Russian thistle is widespread

Seed Mix

- Blue grama
- Sideoats grama
- Western wheatgrass
- Arizona fescue
- Slender wheatgrass
- Alkali sacaton
- Sand dropseed
- Green needlegrass
- Lewis blue flax
- White yarrow
- Fringed sagebrush
- Antelope bitterbrush
- Rocky mountain penstemon
- Yellow prairie coneflower
- Purple prairie clover
- Fourwing saltbrush
- Rubber rabbitbrush
- Galleta grass
- Winterfat

Reseeding

Reseeding

Primary revegetation concerns are:

1) Reduce plant competition and prepare a good seedbed
2) Provide sufficient plant nutrients
3) Seed at proper time and depth
4) Enhance soil moisture through mulching and irrigation

Revegetation Schedule

Procedure	Week* of Month of March	April	May	June	July	Aug.	Sept.	Oct.
Topdress+	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4
Disc[o]	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4				
Fertilize		2,3,4	1,2,3,4	1,2,3,4				
Seed		3,4	1,2,3,4	1,2,3,4	1,2			
Mulch		3,4	1,2,3,4	1,2,3,4	1,2			
Tack Mulch		3,4	1,2,3,4	1,2,3,4	1,2			
Fertilize		1,2,3,4	1,2,3,4					
Irrigate (If necessary)		1,2,3,4,	1,2,3,4	1,2,3,4	1,2,3,4			

* 1 designates first week of the month, 2 designates second week of month, etc.
+ and month of the year.
o Conduct at times when soil is friable.

NM MMD Vegetation Standards

Revegetation success standards for post-mining land uses designated for:

1. Croplands
2. Developed water resources
3. Fish and wildlife habitat*
4. Forest land, recreation land, and shelterbelts
5. Grazing land
6. Industrial/commercial land
7. Pasture land or land occasionally cut for hay
8. Residential

Vegetation standards for above categories based on either a ***technical standard*** or comparison with ***reference area***

NM MMD Vegetation Standards

"Much of the ecological theory that went into developing the SMCRA and state regulations remains centered around Clements' views (Clements 1916, Barbour *et al.* 1987) on the climax community."

"Drastically disturbed lands in the arid southwest are not likely to develop to a climax community during the ten year bond period and therefore are not entirely comparable to reference areas or premine conditions."

"Friedel (1991) and others (Laycock 1991, Westoby *et al.* 1989) have suggested that succession may not produce a single climax vegetation type, but rather multiple steady states -- many of which will ultimately depart from the climax vegetation type."

Development of Technical Standard

- 5-years of baseline, pre-mining plant cover, shrub density, and plant diversity
- Each plant community type of the mine must be represented

Development of Technical Standard for Phase III Bond Release

Cover:

- 13% plant cover, with a minimum of 6 perennial species (4 grasses, 2 forbs)

Diversity Standard for herbaceous species:

- 4 dominant grass, minimum of 5%, maximum of 70% relative cover
- 2 dominant forbs, minimum of 1%, maximum of 70% relative cover

Shrub Density Standard:

- 436 shrubs per acre

Diversity Standard for shrub species:

- 3 shrub species, minimum of 5%, maximum of 90% relative cover

Methods

- Point-intercept sampling was completed at 0.5-meter intervals along 50-meter transects
- Data were collected in 2009, 2010, and 2012
- Sample size (N) = 265 sample locations over 3 sampling years
- At each 0.5-meter interval along the transect, the intercepted location was recorded as the following:
  - Plant species identity
  - Bareground
  - Rock
  - Litter

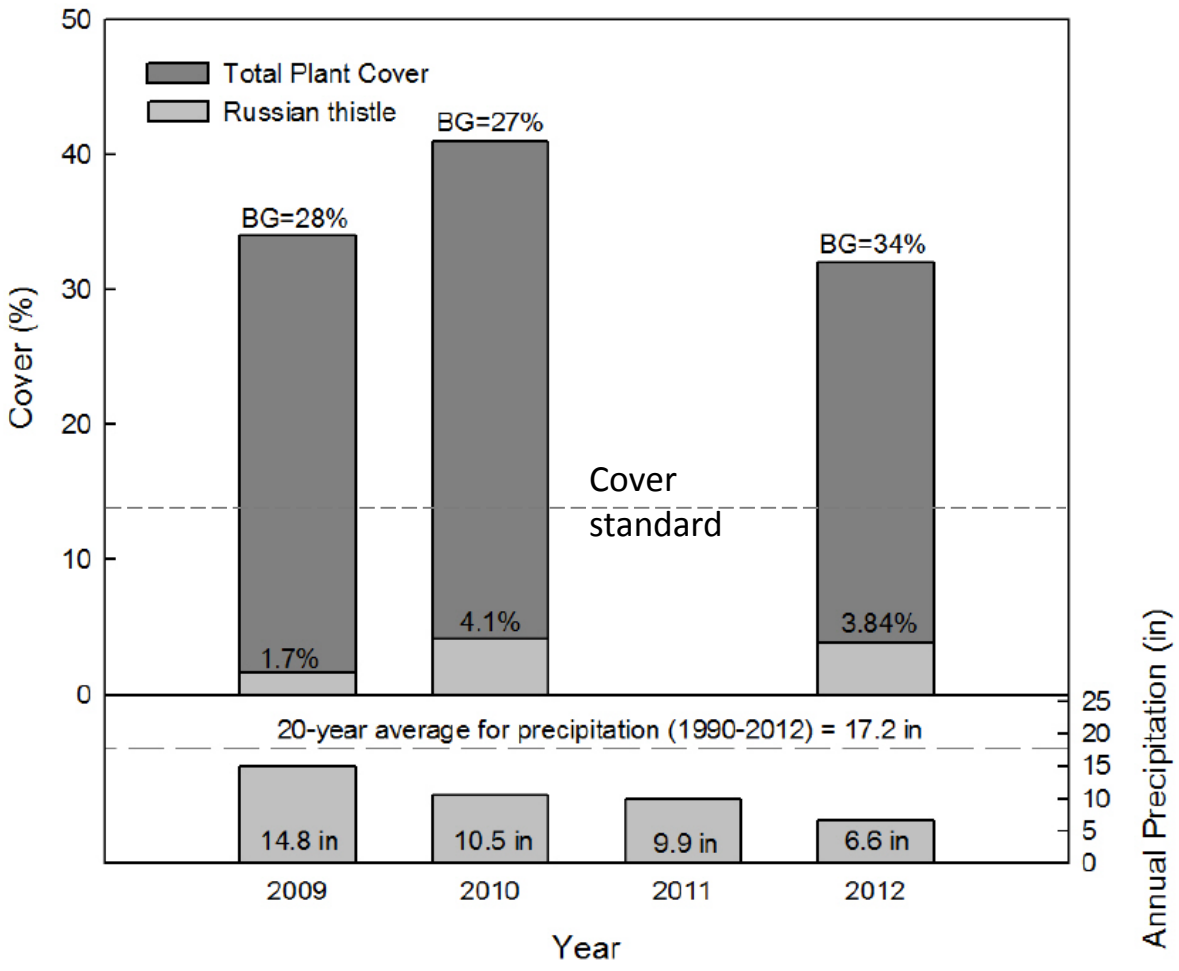
Results

Relative % cover 10 Years Post Mining

GRASSES			FORBS			SHRUBS	
James' galletta	10.7		Russian thistle	5.5		Rabbitbrush	16.5
Western wheatgrass	10.5		Western tansymustard	2.4		Fringed sage	11.2
Blue grama	7.3		White sagebrush	1.2		Winterfat	10.3
Bluebunch wheatgrass	2.9		Prairie coneflower	<1%		Fourwing saltbush	3.1
Tumblegrass	2.1		Thymeleaf sandmat	<1%		Broom snakeweed	2.9
Alkali sacaton	2.0		Curlycup gumweed	<1%		Woods rose	1.2
Prairie junegrass	1.1		Yellow sweetclover	<1%		Utah serviceberry	<1%
Reed canarygrass	<1%		Common sunflower	<1%		Yucca	<1%
Sideoats grama	<1%		Cuman ragweed	<1%		Wavyleaf oak	<1%
Thickspike wheatgrass	<1%		Aster species	<1%		Rocky Mountain juniper	<1%

Results

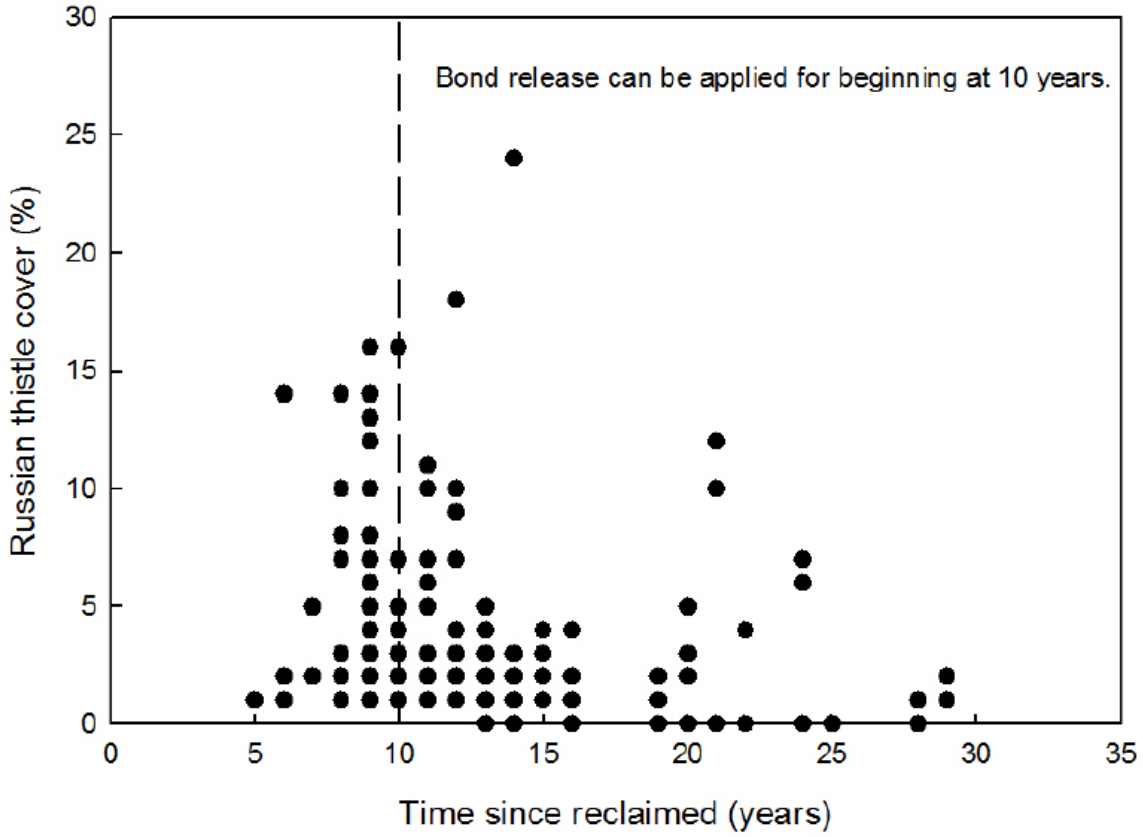
- Total plant cover exceeds 13% vegetation standard
- Average species richness per transect = 10 (data not shown)
- Total annual precipitation was below average in all sampling years
- As drought intensifies, Russian thistle cover appears to increase



Results

Taking a longer term perspective on Russian thistle cover dynamics….

- Russian thistle cover peaks at approximately 8-10 years post-reclamation and then decreases.
- By years 20-30, Russian thistle cover is generally < 5%.



Conclusions

Management of Russian thistle in reclaimed areas requires:

1) a longer-term perspective
2) acceptance of this species' temporary abundance during drought
3) use of mid- to late-seral seed mix
4) adaptive management strategies
5) understanding of ecological processes
6) collaborative regulatory framework
7) monitoring and data collection
8) re-evaluation


Questions?